Claims

1. A closed three-site quantum particle system, comprising:

a first site in which the energy is controllable;

a second site in which the energy is controllable;

states in the first and second sites that are strongly coupled to each other by coherent tunnelling, and where the tunelling rate is controllable; and,

a third site in which the energy is controllable, and where the state in the third site is weakly coupled by coherent tunnelling to the first and second states, so that the third state is able to map out the populations of the first and second states as its energy is scanned with respect to the first and second states.

2. A system according to claim 1, wherein the first and second states are a solid-state charge qubit with one particle shared between the two sites.

3. A system according to claim 2, wherein the system is operated in the superposition basis with an integrated readout using the third site as a probe state.

4. A system according to claim 1, 2 or 3 wherein Adiabatic Fast Passage (AFP) is employed as a readout mechanism.

5. A system according to claim 4, wherein the difference between the probe energy and the qubit, and the tunnelling rate between the probe and the qubit are modulated to effect AFP.

6. A system according to claim 4, wherein the AFP trajectory is reversed to re-initialise the qubit into a known state.

7. A system according to any preceding claim, wherein the energies and tunnelling rates are controlled using gate electrodes.

8. A system according to claim 7, wherein the voltages on the gate electrodes are controlled.

9. A system according to claim 7, wherein a sensitive electrometer is used for reading out the population in the third state.

10. A system according to claim 9, wherein the electrometer is realised by a single electron transistor (SET) which monitors the charge in the third, weakly coupled, site.

11. A system according to claim 10, wherein the electrometer is realised by a quantum point contact.

12. A system according to any preceding claim when used for readout from a quantum computer.

13. A system according to claim 1, wherein alternatively, the first site involves a solid-state spin qubit, and the second site involves a reference spin, and the third site is used as a probe site.

14. A system according to claim 13, wherein the relative spins of the first and second sites are converted into charge distribution information.

15. A system according to claim 13 or 14, wherein Adiabatic Fast Passage (AFP) is employed as a readout mechanism.

16. A system according to claim 15, wherein the difference between the probe energy and the qubit, and the tunnelling rate between the probe and the reference states are modulated to effect AFP.

17. A system according to claim 16, wherein the AFP trajectory is reversed to re-initialise the qubit into a known state.

18. A system according to any one of claims 13 to 16, wherein the energies and tunnelling rates are controlled using gate electrodes.

19. A system according to claim 18, wherein the voltages on the gate electrodes are controlled.

20. A system according to claim 19, wherein a sensitive electrometer is used for reading out the population in the third state.

21. A system according to claim 20, wherein the electrometer is realised by a single electron transistor (SET) which monitors the charge in the third, weakly coupled, site.

22. A system according to claim 21, wherein the electrometer is realised by a quantum point contact.

23. A system according to any one of claims 13 to 21, applied to readout from a quantum computer.

24. A system according to claim 23, wherein the quantum computer uses nuclear spin or electron spin qubits.

25. A system according to claim 1, wherein the system is used with flux quanta or 2D electron gas, and a third state introduced for readout.

26. A readout method for a closed three-state quantum particle system, comprising the following steps:

controlling the energy of a first site;

controlling the energy of a second site;

controlling the tunnelling rate between the first and second sites, which are strongly coupled to each other by coherent tunnelling; and,

controlling the energy of a third site, the state in the third site being weakly coupled by coherent tunnelling to the first and second states, so the third state is able to map out the populations of the first and second states as its energy is scanned with respect to the first and second states.

27. A method according to claim 26 wherein Adiabatic Fast Passage (AFP) is employed as a readout mechanism.

28. A method according to claim 27, wherein the difference between the probe energy and the qubit, and the tunnelling rate between the probe and the qubit are modulated to effect AFP.

29. A method according to claim 27, wherein the AFP trajectory is reversed to re-initialise the qubit into a known state.

30. A method according to any one of claims 26 to 29, wherein the energies and tunnelling rates are controlled using gate electrodes.

31. A method according to claim 30, wherein the voltages on the gate electrodes are controlled.

32. A method according to claim 30, wherein a sensitive electrometer is used for reading out the population in the third state.

33. A method according to claim 32, wherein the electrometer is realised by a single electron transistor (SET) which monitors the charge in the third, weakly coupled, site.

34. A system according to claim 32, wherein the electrometer is realised by a quantum point contact.

35. A readout method for a closed three-state quantum particle system, comprising the following steps:

mapping bases into different energy states which are resolvable within the linewidth limitations of controlled tunnelling to a probe state, where the mapping requires two or more parameters to be modulated to force the system to remain on a specific adiabatic pathway; the parameters may be the difference between the probe energy and the qubit, and the tunnelling rate between the probe and the qubit or reference state.

36. A method according to claim 35, comprising the further step of re-initialisation by reversing the AFP trajectory so that the qubit is set into a known state.

37. A method according to claims 35 to 36, wherein the energies and tunnelling rates are controlled using gate electrodes.

38. A method according to claim 37, wherein the voltages on the gate electrodes are controlled.

39. A method according to claim 38, wherein a sensitive electrometer is used for reading out the population in the third state.

40. A method according to claim 39, wherein the electrometer is realised by a single electron transistor (SET) which monitors the charge in the third, weakly coupled, site.

41. A system according to claim 39, wherein the electrometer is realised by a quantum point contact.